PATENT ABSTRACTS OF JAPAN

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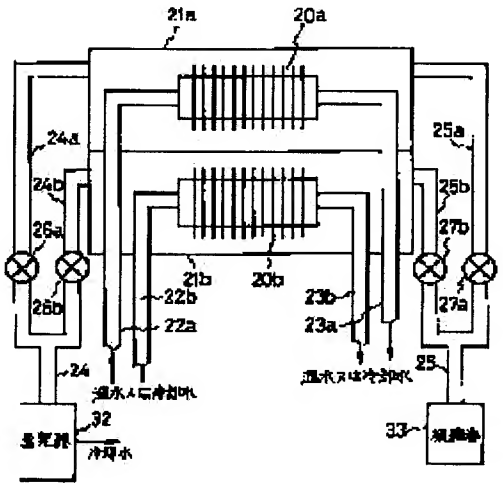
(54) ADSORPTION TYPE REFRIGERATOR

(57)Abstract:
PURPOSE: To provide an adsorption type refrigerator in which an efficiency can be improved by improving a coefficient of performance while utilizing the advantage of the refrigerator of a low running cost.
CONSTITUTION: A moisture adsorbing material is disposed on an outer surface of a heat exchanging member 20 including fins to adsorb moisture in contact of the air evaporated from an evaporator 32 with the outer surface of the one heat exchanging member 20b. Adsorption heat generated at this time is removed by cooling water which flows in the member. On the other hand, warm drain is fed to the other heat exchanging member 20a to be heated, and the material is desorbed. The air containing desorbed moisture is condensed by a condenser 33. Regenerating step and adsorbing step of the members 20a, 20b are alternately executed to continuously make chilled water by the evaporator 32.



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CLAIMS

[Claim(s)]
[Claim 1] The tubed heat exchange member by which water adsorption material has been arranged at the outside-surface part, and an evaporator, An adsorption means to make the outside of said heat exchange member carry out conduction of the steam from this evaporator, and to make moisture stick to said adsorption material, A cooling means to carry out conduction of the cooling fluid inside said heat exchange member at the time of this adsorption, The adsorption equation refrigerator characterized by having a playback means to make carry out conduction of the thermal fluid inside said heat exchange member, and to reproduce said adsorption material, and the condenser which condenses the steam which carried out desorption from said adsorption material by playback at the time of this playback.
[Claim 2] At least two sets of the tubed heat exchange members by which water adsorption material has been arranged at the outside-surface part An evaporator and an adsorption means to make the outside of said heat exchange member carry out conduction of the steam from this evaporator, and to make moisture stick to said adsorption material, A cooling means to carry out conduction of the cooling fluid inside said heat exchange member at the time of this adsorption, A playback means to make carry out conduction of the thermal fluid inside said heat exchange member, and to reproduce said adsorption material, The condenser which condenses the steamy content resurgent gas which carried out desorption from said adsorption material by playback at the time of this playback, The adsorption equation refrigerator characterized by having the control means which divides said heat exchange member into two groups, and carries out supply of the outside steam and inside cooling fluid to said heat exchange member, supply of the inside heat carrier fluid to said heat exchange member, and the extract of outside resurgent gas by turns.
[Claim 3] Said heat exchange member is an adsorption equation refrigerator according to claim 1 or 2 characterized by preparing two or more fins in that outside surface, and the front face of this fin constituting said outside surface of said heat exchange member.
[Claim 4] Said adsorption material is an adsorption equation refrigerator according to claim 1 or 2 characterized by being at least one sort chosen from the group which consists of silica gel, a zeolite, an activated alumina, and activated carbon.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention uses the latent heat of vaporization of the refrigerant within a low-pressure well-closed container, makes the generated refrigerant steam stick to adsorption material, and relates to an adsorption equation refrigerator effective in manufacturing cold water about 5 degrees C or more especially using heat exchange members, such as a plate fin mold heat-transfer element, shell, a tube mold heat-transfer element, and an erotic fin mold heat-transfer element, about the adsorption equation refrigerator which a refrigerant is evaporated continuously and obtains cold energy.
[0002]
[Description of the Prior Art] There are a technique of manufacturing cold water by the latent heat of vaporization in case a refrigerant evaporates as a means to manufacture cold water, using a steamy compression refrigerating machine, a technique of evaporating water within the container decompressed so that water might evaporate at low temperature using an absorption refrigerator, and manufacturing cold water by the latent heat of vaporization, and a technique of manufacturing cold water with an adsorption equation refrigerator by making the pellet of silica gel into adsorption material.
[0003] Although the steamy compression refrigerating machine is generally conventionally used for manufacture of cold water, this steamy compression refrigerating machine has the trouble that consumption energy is high, in order that it is going to be contrary to the request of the latest dechlorofluocarbon since chlorofluocarbon is used, and the heat of condensation may carry out [and] condensation removal of the large moisture.
[0004] On the other hand, although an absorption refrigerator does not produce the problem of chlorofluocarbon, as compared with a steamy compression refrigerating machine, the high pressure steam of about 8 kgf/cm2G is needed in effectiveness being bad and gathering this frozen effectiveness. An installation will be restrained, and equipment enlarges the feeder of such a high pressure steam as compared with a steamy compression refrigerating machine, and it has the difficulty that maintenance is difficult.
[0005] Since the adsorption equation refrigerator is using silica gel for adsorption material, by using thermal wastewater, such as works and a cogeneration system, as compared with an absorption refrigerator, although effectiveness is bad, a running cost becomes very low and it has the advantage that there is little change of the effectiveness by fluctuation of the warm water temperature at the time of desorption.
[0006] The evaporator 1 which carries out an adsorption process, and the adsorption material heat exchanger 3 are connected in [the condenser 2 and the adsorption material heat exchanger 4 which carry out a playback process again] airtight, and this adsorption equation refrigerator is held at a high vacuum, as shown in drawing 3 (the number for clean energy February, 1993 the 35th thru/or 40 pages). Although two heat exchangers 3 and 4 are formed, a playback process and an adsorption process are carried out by turns, and, thereby, each of these is connected with an evaporator 1 or a condenser 2 by turns. The refrigerant 8 of Te exists [temperature] in the interior of an evaporator 1, and the refrigerant 8 of Tc exists [temperature] in a condenser 2. This refrigerant is water. Moreover, although the adsorption material 7 is stored in the adsorption material heat exchanger 3 and 4, as for the adsorption material 7 in the adsorption material heat exchanger 4 of a playback process, the temperature of the temperature of the adsorption material 7 in Tr and the adsorption material heat exchanger 3 of an adsorption process is Ta. This adsorption material is silica system solid-state adsorption material.
[0007] At a playback process, from a heat source, the refrigerant to which that temperature was rising from Ta to Tr in response to heat, and it was sticking serves as a steam, desorption of the adsorption material 7 of the adsorption material heat exchanger 4 is carried out, and this steam serves as water with a condenser 2 at condensation temperature Tc (pressure Pc). By this actuation, the water content of adsorption material shifts to qa from qb in an amount-of-adsorption diagram, such as being shown in drawing 4 .
[0008] Moreover, in an adsorption process, since the percentage of saturatel water content of adsorption material increases the adsorption material 7 in the adsorption material heat exchanger 3 from qa to qb by being cooled until temperature is set to Ta from Tr with cooling water etc., a refrigerant takes heat from the outside of a system, evaporates it at the evaporation temperature Te (pressure Pe) in an evaporator 1, and is adsorbed by the adsorption material 7. Moreover, since the heat of adsorption generated at the time of adsorption is taken by cooling water, temperature is held at Ta and the adsorption material 7 is continuously adsorbed by the adsorption material 7 in a refrigerant. When two sets of heat exchangers 3 and 4 repeat such a process by turns, cold water is continuously obtained from an evaporator 1.
[0009]
[Problem(s) to be Solved by the Invention] However, this conventional adsorption equation refrigerator has the difficulty that cold-water manufacture effectiveness is low. If 29 degrees C and warm water inlet temperature are set into 75 degrees C and a steam is set [12 degrees C and refrigerating capacity] to 8 kgf/cm2G for 10USRT(s) (30240 kcal/H) and cooling water inlet temperature at 14 degrees C and a cold-water outlet, compressor capacity is sometimes for example, excellent [it is a cold-water inlet port about cold-water conditions, and / with 3.4] in the coefficient of performance COP in 7.5kW and the maximum stream flow in the case of the steamy compression refrigerating machine 3/12m. In addition, in a refrigerator, although a heating value Q is pumped up, this coefficient of performance is the index the work W of which to consume, and expresses the effectiveness of a refrigerator. However,

in this steamy compression refrigerating machine, if power is required to drive a compressor and the generating efficiency for it is taken into consideration, it will be thought that a coefficient of performance COP becomes about one. On the other hand, steam consumption of an absorption refrigerator is 45kg/o'clock, and a coefficient of performance is 1.2.

[0010] On the other hand, an adsorption equation refrigerator has a very low coefficient of performance as compared with 0.56, and a steamy compression refrigerating machine and an absorption refrigerator.

[0011] It aims at this invention being made in view of this trouble, and offering the adsorption equation refrigerator which can raise a coefficient of performance and can raise effectiveness, employing efficiently the advantage of the adsorption equation refrigerator that a running cost is low.

[0012]

[Means for Solving the Problem] The tubed heat exchange member by which, as for the 1st adsorption equation refrigerator concerning this invention, water adsorption material has been arranged at the outside-surface part, An evaporator and an adsorption means to make the outside of said heat exchange member carry out conduction of the steam from this evaporator, and to make moisture stick to said adsorption material, It is characterized by having a cooling means to carry out conduction of the cooling fluid inside said heat exchange member at the time of this adsorption, a playback means to make carry out conduction of the thermal fluid inside said heat exchange member, and to reproduce said adsorption material, and the condenser that condenses the steam which carried out desorption from said adsorption material by playback at the time of this playback.

[0013] At least two sets of the tubed heat exchange members by which, as for the 2nd adsorption equation refrigerator concerning this invention, water adsorption material has been arranged at the outside-surface part An evaporator and an adsorption means to make the outside of said heat exchange member carry out conduction of the steam from this evaporator, and to make moisture stick to said adsorption material, A cooling means to carry out conduction of the cooling fluid inside said heat exchange member at the time of this adsorption, A playback means to make carry out conduction of the thermal fluid inside said heat exchange member, and to reproduce said adsorption material, The condenser which condenses the steamy content resurgent gas which carried out desorption from said adsorption material by playback at the time of this playback, It is characterized by having the control means which divides said heat exchange member into two groups, and carries out supply of the outside steam and inside cooling fluid to said heat exchange member, supply of the inside heat carrier fluid to said heat exchange member, and the extract of outside resurgent gas by turns.

[0014] In this case, to said heat exchange member, two or more fins are prepared in that outside surface, and it is desirable that it is that from which the front face of this fin also constitutes said outside surface of said heat exchange member.

[0015] Moreover, as said adsorption material, there is silica gel, a zeolite, an activated alumina, or activated carbon.

[0016]

[Function] In this invention, prepare adsorption material in the outside surface of a tubed heat exchange member, and the interior of a heat exchange member is made to carry out conduction of a thermal fluid or the cooling fluid, and the adsorption material of the outside surface of a heat exchange member is heated, or it cools. By this, adsorption material is heated, a playback process is carried out in the heat exchange member in which thermal fluids, such as 75-degree C thermal wastewater, are carrying out conduction, and desorption of the moisture is carried out. This desorption moisture serves as a steam, goes into a condenser, and is cooled and condensed with a condenser. On the other hand, conduction of the steam generated in the evaporator is contacted and carried out to the adsorption material of a heat exchange member, and it is adsorbed by adsorption material in the moisture. In an evaporator, the cold water which the latent heat of vaporization was taken and was cooled is obtained. In this adsorption process, since the interior of a heat exchange member is made to carry out conduction of the cooling fluid, adsorption material does not carry out a temperature up with a heat of adsorption, adsorption effectiveness does not necessarily fall, it is always efficient and an adsorption process is carried out. Thus, in this adsorption process, while heat exchange is carried out inside the outside-surface side of a tubed heat exchange member and an adsorption process and a playback process are carried out by turns, since adsorption material is cooled with the cooling fluid, adsorption effectiveness is high in this invention. Therefore, the extremely excellent frozen effectiveness can be acquired and a coefficient of performance can be raised.

[0017]

[Example] Hereafter, the example of this invention is concretely explained with reference to an attached drawing. Drawing 1 is the front view showing the heat exchange member 20 of the adsorption refrigerator concerning the example of this invention. Fitting of two or more aluminum plate fins 12 is carried out to the heat exchange tubing (copper tube) 11. And the water adsorption material 13 is arranged all over the peripheral face of these copper tubes 1, and the front face of a fin 12. This adsorption material 13 can apply an acrylic adhesiveness binder all over the peripheral face of a copper tube 11, and the front face of a fin 12, and can form it by installing it on this acrylic adhesion material binder film, as a silica gel particle is embedded. Moreover, the powder of silica gel is kneaded with water glass, and after extruding and applying this to the peripheral face of a copper tube 11, and the front face of a fin 12, desiccation baking of the part for water glass can be carried out, and adsorption material can be prepared by fixing silica gel powder and water glass on a fin front face etc. Anyway, what is necessary is just to fix by applying the powder or particle of adsorption material to the front face of a heat exchange member, or pasting up. As adsorption material, a zeolite, activated carbon, an activated alumina, etc. are out of silica gel.

[0018] Moreover, although the heat exchange member shown in drawing 1 is the heat-transfer element of a plate fin mold, the heat-transfer element of not only a such type thing but a shell and a tube mold, or an erotic fin mold etc. can also be used, and the heat-transfer element of the shape of single tubing which does not have a fin further may be used.

[0019] The adsorption equation refrigerator of this example is constituted as shown in drawing 2 using this heat exchange member 20 (20a, 20b). It is contained in airtight in housing 21a and 21b, and, as for each heat exchange members 20a and 20b, warm water or cooling water is supplied through Piping 22a and 22b inside these heat exchange members 20a and 20b, respectively. This warm water or cooling water carries out conduction of the interior of the heat exchange members 20a and 20b, and after it heats the heat exchange members 20a and 20b or cools, it is discharged through Piping 23a and 23b. These piping 22a, 22b, 23a, and 23b is drawn by the exterior of Housing 21a and 21b.

[0020] The piping 24a and 24b which is open for free passage in housing 21a and 21b is connected with one edge of

Housing 21a and 21b, and Piping 25a and 25b is connected with the other-end section of Housing 21a and 21b. Piping 24a and 24b is connected with piping 24 by each, and Housing 21a and 21b is connected with the evaporator 32 through these piping 24, 24a, and 24b. On the other hand, Piping 25a and 25b is connected with piping 25 by each, and Housing 21a and 21b is connected with the condenser 33 through these piping 25, 25a, and 25b.
[0021] The closing motion valves 26a and 26b are formed in Piping 24a and 24b, and the closing motion valves 27a and 27b are formed in Piping 25a and 25b. Each of these housing and piping are held airtightly. Moreover, the inside of housing 21a and 21b is held at the vacua.
[0022] Next, actuation of the adsorption equation refrigerator constituted in this way is explained. First, heat exchange member 20a presupposes that playback process and heat exchange member 20b is carrying out the adsorption process. The closing motion valves 26a and 27b are made close, and the closing motion valves 26b and 27a are made open. Moreover, the interior of heat exchange member 20a is made to carry out conduction of the warm water through Piping 22a and 23a. This warm water can use what is discharged as thermal wastewater at works. Moreover, the interior of heat exchange member 20b is made to carry out conduction of the cooling water through Piping 22b and 23b. This cooling water can use the about 29-degree C water supplied from a cooling tower.
[0023] If it does so, the interior of an evaporator 32 and housing 21b will be open for free passage, the adsorption material by which the refrigerant steam which evaporated with the evaporator 32 was formed in the outside surface of heat exchange member 20b will be contacted, and adsorption material will be adsorbed in a refrigerant steam. As a result of moisture's adsorbing in the adsorption material of this heat exchanger 20b, in an evaporator 32, evaporation advances further. In this case, since cooling water is carrying out conduction of the interior of heat exchanger 20b and heat exchanger 20b is cooled, even if generation of heat arises by the adsorption reaction of adsorption material, since adsorption material is cooled, adsorption effectiveness does not fall.
[0024] Thus, as a result of evaporation advancing with an evaporator 32, water is cooled by the latent heat of vaporization and cold water is manufactured.
[0025] On the other hand, since thermal wastewater is carrying out conduction of the interior in heat exchange member 20a, the adsorption material is heated and adsorption material carries out desorption of the moisture to which it was sticking at low temperature comparatively to the bottom of a vacuum. Since housing 21a is open for free passage with the condenser 33, it is cooled with a condenser 33 and moisture condenses the refrigerant steam which carried out desorption from adsorption material. In heat exchanger 20a, the desorption of moisture advances further by condensation of this moisture, and adsorption material is reproduced.
[0026] Thus, after playback of adsorption material is completed in heat exchange member 20a and water adsorption is completed in heat exchange member 20b, the closing motion valves 26a and 27b are made open, and the closing motion valves 26b and 27a are made close. If it does so, an adsorption process will be carried out in heat exchange member 20a, and a playback process will be carried out in heat exchange member 20b. Thus, cold water is continuously manufactured from an evaporator 32 by carrying out a playback process and an adsorption process by turns by the heat exchange members 20a and 20b.
[0027] In this example, since the heat exchange member 20 (20a, 20b) has a fin 12 like drawing 1 and the adsorption material 13 is formed also in this fin 12, an adsorption area is large, it is efficient, and moisture adsorbs. Moreover, in an adsorption process, since cooling water carried out conduction of the interior of the heat exchange member 20 and adsorption material is cooled, even if generation of heat by the adsorption reaction arises, adsorption effectiveness does not fall and high adsorption effectiveness is maintained. Consequently, according to the adsorption equation refrigerator of this example, it is very efficient and cold water can be obtained. For this reason, a coefficient of performance is high.
[0028] Next, drawing 1 and the adsorption equation refrigerator shown in 2 are actually manufactured, and the result of having asked for the coefficient of performance is explained. The fin pitch of this heat exchange member is 3.5mm. The heating area of each heat exchange member is 2 29m, and the change of a closing motion valve, i.e., the change to a playback process and an adsorption process, is for 5 minutes. The acrylic adhesiveness binder was applied all over the plate fin made from aluminum, and the silica gel whose grain size is 20 thru/or 35 meshes was pasted up on the front face two times 680 g/m. A heat carrier is 75-degree C thermal wastewater, and the cooling water of the medium inside the heat exchange tubing 1 is cooling tower water.
[0029] Consequently, that that whose warm water was 75 degrees C at the entrance fell to 70 degrees C at the outlet, and cold water's was [that] 14 degrees C at the entrance fell to 12 degrees C at the outlet. The heating value by the side of warm water was 63kW, and the heating value by the side of cooling water was 82.5kW. Consequently, coefficients of performance were 82.5 / 63= 1.31.
[0030]
[Effect of the Invention] The coefficient of performance can be raised more than the coefficient of performance of other steamy compression refrigerating machines and an absorption refrigerator, employing efficiently the advantage that the running cost of an adsorption equation refrigerator is low according to this invention, as explained above. For this reason, this invention does so the outstanding effectiveness that it is very efficient and cold water can be manufactured.

[Translation done.]

TECHNICAL FIELD

[Industrial Application] This invention uses the latent heat of vaporization of the refrigerant within a low-pressure well-closed container, makes the generated refrigerant steam stick to adsorption material, and relates to an adsorption equation refrigerator effective in manufacturing cold water about 5 degrees C or more especially using heat exchange members, such as a plate fin mold heat-transfer element, shell, a tube mold heat-transfer element, and an erotic fin mold heat-transfer element, about the adsorption equation refrigerator which a refrigerant is evaporated continuously and obtains cold energy.

[Translation done.]

PRIOR ART

[Description of the Prior Art] There are a technique of manufacturing cold water by the latent heat of vaporization in case a refrigerant evaporates as a means to manufacture cold water, using a steamy compression refrigerating machine, a technique of evaporating water within the container decompressed so that water might evaporate at low temperature using an absorption refrigerator, and manufacturing cold water by the latent heat of vaporization, and a technique of manufacturing cold water with an adsorption equation refrigerator by making the pellet of silica gel into adsorption material.

[0003] Although the steamy compression refrigerating machine is generally conventionally used for manufacture of cold water, this steamy compression refrigerating machine has the trouble that consumption energy is high, in order that it is going to be contrary to the request of the latest dechlorofluocarbon since chlorofluocarbon is used, and the heat of condensation may carry out [and] condensation removal of the large moisture.

[0004] On the other hand, although an absorption refrigerator does not produce the problem of chlorofluocarbon, as compared with a steamy compression refrigerating machine, the high pressure steam of about 8 kgf/cm2G is needed in effectiveness being bad and gathering this frozen effectiveness. An installation will be restrained, and equipment enlarges the feeder of such a high pressure steam as compared with a steamy compression refrigerating machine, and it has the difficulty that maintenance is difficult.

[0005] Since the adsorption equation refrigerator is using silica gel for adsorption material, by using thermal wastewater, such as works and a cogeneration system, as compared with an absorption refrigerator, although effectiveness is bad, a running cost becomes very low and it has the advantage that there is little change of the effectiveness by fluctuation of the warm water temperature at the time of desorption.

[0006] The evaporator 1 which carries out an adsorption process, and the adsorption material heat exchanger 3 are connected in [the condenser 2 and the adsorption material heat exchanger 4 which carry out a playback process again] airtight, and this adsorption equation refrigerator is held at a high vacuum, as shown in drawing 3 (the number for clean energy February, 1993 the 35th thru/or 40 pages). Although two heat exchangers 3 and 4 are formed, a playback process and an adsorption process are carried out by turns, and, thereby, each of these is connected with an evaporator 1 or a condenser 2 by turns. The refrigerant 8 of Te exists [temperature] in the interior of an evaporator 1, and the refrigerant 8 of Tc exists [temperature] in a condenser 2. This refrigerant is water. Moreover, although the adsorption material 7 is stored in the adsorption material heat exchanger 3 and 4, as for the adsorption material 7 in the adsorption material heat exchanger 4 of a playback process, the temperature of the temperature of the adsorption material 7 in Tr and the adsorption material heat exchanger 3 of an adsorption process is Ta. This adsorption material is silica system solid-state adsorption material.

[0007] At a playback process, from a heat source, the refrigerant to which that temperature was rising from Ta to Tr in response to heat, and it was sticking serves as a steam, desorption of the adsorption material 7 of the adsorption material heat exchanger 4 is carried out, and this steam serves as water with a condenser 2 at condensation temperature Tc (pressure Pc). By this actuation, the water content of adsorption material shifts to qa from qb in an amount-of-adsorption diagram, such as being shown in drawing 4 .

[0008] Moreover, in an adsorption process, since the percentage of saturatel water content of adsorption material increases the adsorption material 7 in the adsorption material heat exchanger 3 from qa to qb by being cooled until temperature is set to Ta from Tr with cooling water etc., a refrigerant takes heat from the outside of a system, evaporates it at the evaporation temperature Te (pressure Pe) in an evaporator 1, and is adsorbed by the adsorption material 7. Moreover, since the heat of adsorption generated at the time of adsorption is taken by cooling water, temperature is held at Ta and the adsorption material 7 is continuously adsorbed by the adsorption material 7 in a refrigerant. When two sets of heat exchangers 3 and 4 repeat such a process by turns, cold water is continuously obtained from an evaporator 1.

[0009]

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] The coefficient of performance can be raised more than the coefficient of performance of other steamy compression refrigerating machines and an absorption refrigerator, employing efficiently the advantage that the running cost of an adsorption equation refrigerator is low according to this invention, as explained above. For this reason, this invention does so the outstanding effectiveness that it is very efficient and cold water can be manufactured.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, this conventional adsorption equation refrigerator has the difficulty that cold-water manufacture effectiveness is low. If 29 degrees C and warm water inlet temperature are set into 75 degrees C and a steam is set [12 degrees C and refrigerating capacity] to 8 kgf/cm2G for 10USRT(s) (30240 kcal/H) and cooling water inlet temperature at 14 degrees C and a cold-water outlet, compressor capacity is sometimes for example, excellent [it is a cold-water inlet port about cold-water conditions, and / with 3.4] in the coefficient of performance COP in 7.5kW and the maximum stream flow in the case of the steamy compression refrigerating machine 3/12m. In addition, in a refrigerator, although a heating value Q is pumped up, this coefficient of performance is the index the work W of which to consume, and expresses the effectiveness of a refrigerator. However, in this steamy compression refrigerating machine, if power is required to drive a compressor and the generating efficiency for it is taken into consideration, it will be thought that a coefficient of performance COP becomes about one. On the other hand, steam consumption of an absorption refrigerator is 45kg/o'clock, and a coefficient of performance is 1.2.

[0010] On the other hand, an adsorption equation refrigerator has a very low coefficient of performance as compared with 0.56, and a steamy compression refrigerating machine and an absorption refrigerator.

[0011] It aims at this invention being made in view of this trouble, and offering the adsorption equation refrigerator which can raise a coefficient of performance and can raise effectiveness, employing efficiently the advantage of the adsorption equation refrigerator that a running cost is low.

[Translation done.]

MEANS

[Means for Solving the Problem] The tubed heat exchange member by which, as for the 1st adsorption equation refrigerator concerning this invention, water adsorption material has been arranged at the outside-surface part, An evaporator and an adsorption means to make the outside of said heat exchange member carry out conduction of the steam from this evaporator, and to make moisture stick to said adsorption material, It is characterized by having a cooling means to carry out conduction of the cooling fluid inside said heat exchange member at the time of this adsorption, a playback means to make carry out conduction of the thermal fluid inside said heat exchange member, and to reproduce said adsorption material, and the condenser that condenses the steam which carried out desorption from said adsorption material by playback at the time of this playback.
[0013] At least two sets of the tubed heat exchange members by which, as for the 2nd adsorption equation refrigerator concerning this invention, water adsorption material has been arranged at the outside-surface part An evaporator and an adsorption means to make the outside of said heat exchange member carry out conduction of the steam from this evaporator, and to make moisture stick to said adsorption material, A cooling means to carry out conduction of the cooling fluid inside said heat exchange member at the time of this adsorption, A playback means to make carry out conduction of the thermal fluid inside said heat exchange member, and to reproduce said adsorption material, The condenser which condenses the steamy content resurgent gas which carried out desorption from said adsorption material by playback at the time of this playback, It is characterized by having the control means which divides said heat exchange member into two groups, and carries out supply of the outside steam and inside cooling fluid to said heat exchange member, supply of the inside heat carrier fluid to said heat exchange member, and the extract of outside resurgent gas by turns.
[0014] In this case, to said heat exchange member, two or more fins are prepared in that outside surface, and it is desirable that it is that from which the front face of this fin also constitutes said outside surface of said heat exchange member.
[0015] Moreover, as said adsorption material, there is silica gel, a zeolite, an activated alumina, or activated carbon.

[Translation done.]

OPERATION

[Function] In this invention, prepare adsorption material in the outside surface of a tubed heat exchange member, and the interior of a heat exchange member is made to carry out conduction of a thermal fluid or the cooling fluid, and the adsorption material of the outside surface of a heat exchange member is heated, or it cools. By this, adsorption material is heated, a playback process is carried out in the heat exchange member in which thermal fluids, such as 75-degree C thermal wastewater, are carrying out conduction, and desorption of the moisture is carried out. This desorption moisture serves as a steam, goes into a condenser, and is cooled and condensed with a condenser. On the other hand, conduction of the steam generated in the evaporator is contacted and carried out to the adsorption material of a heat exchange member, and it is adsorbed by adsorption material in the moisture. In an evaporator, the cold water which the latent heat of vaporization was taken and was cooled is obtained. In this adsorption process, since the interior of a heat exchange member is made to carry out conduction of the cooling fluid, adsorption material does not carry out a temperature up with a heat of adsorption, adsorption effectiveness does not necessarily fall, it is always efficient and an adsorption process is carried out. Thus, in this adsorption process, while heat exchange is carried out inside the outside-surface side of a tubed heat exchange member and an adsorption process and a playback process are carried out by turns, since adsorption material is cooled with the cooling fluid, adsorption effectiveness is high in this invention. Therefore, the extremely excellent frozen effectiveness can be acquired and a coefficient of performance can be raised.

[Translation done.]

EXAMPLE

[Example] Hereafter, the example of this invention is concretely explained with reference to an attached drawing. Drawing 1 is the front view showing the heat exchange member 20 of the adsorption refrigerator concerning the example of this invention. Fitting of two or more aluminum plate fins 12 is carried out to the heat exchange tubing (copper tube) 11. And the water adsorption material 13 is arranged all over the peripheral face of these copper tubes 1, and the front face of a fin 12. This adsorption material 13 can apply an acrylic adhesiveness binder all over the peripheral face of a copper tube 11, and the front face of a fin 12, and can form it by installing it on this acrylic adhesion material binder film, as a silica gel particle is embedded. Moreover, the powder of silica gel is kneaded with water glass, and after extruding and applying this to the peripheral face of a copper tube 11, and the front face of a fin 12, desiccation baking of the part for water glass can be carried out, and adsorption material can be prepared by fixing silica gel powder and water glass on a fin front face etc. Anyway, what is necessary is just to fix by applying the powder or particle of adsorption material to the front face of a heat exchange member, or pasting up. As adsorption material, a zeolite, activated carbon, an activated alumina, etc. are out of silica gel.

[0018] Moreover, although the heat exchange member shown in drawing 1 is the heat-transfer element of a plate fin mold, the heat-transfer element of not only a such type thing but a shell and a tube mold, or an erotic fin mold etc. can also be used, and the heat-transfer element of the shape of single tubing which does not have a fin further may be used.

[0019] The adsorption equation refrigerator of this example is constituted as shown in drawing 2 using this heat exchange member 20 (20a, 20b). It is contained in airtight in housing 21a and 21b, and, as for each heat exchange members 20a and 20b, warm water or cooling water is supplied through Piping 22a and 22b inside these heat exchange members 20a and 20b, respectively. This warm water or cooling water carries out conduction of the interior of the heat exchange members 20a and 20b, and after it heats the heat exchange members 20a and 20b or cools, it is discharged through Piping 23a and 23b. These piping 22a, 22b, 23a, and 23b is drawn by the exterior of Housing 21a and 21b.

[0020] The piping 24a and 24b which is open for free passage in housing 21a and 21b is connected with one edge of Housing 21a and 21b, and Piping 25a and 25b is connected with the other-end section of Housing 21a and 21b. Piping 24a and 24b is connected with piping 24 by each, and Housing 21a and 21b is connected with the evaporator 32 through these piping 24, 24a, and 24b. On the other hand, Piping 25a and 25b is connected with piping 25 by each, and Housing 21a and 21b is connected with the condenser 33 through these piping 25, 25a, and 25b.

[0021] The closing motion valves 26a and 26b are formed in Piping 24a and 24b, and the closing motion valves 27a and 27b are formed in Piping 25a and 25b. Each of these housing and piping are held airtightly. Moreover, the inside of housing 21a and 21b is held at the vacua.

[0022] Next, actuation of the adsorption equation refrigerator constituted in this way is explained. First, heat exchange member 20a presupposes that playback process and heat exchange member 20b is carrying out the adsorption process. The closing motion valves 26a and 27b are made close, and the closing motion valves 26b and 27a are made open. Moreover, the interior of heat exchange member 20a is made to carry out conduction of the warm water through Piping 22a and 23a. This warm water can use what is discharged as thermal wastewater at works. Moreover, the interior of heat exchange member 20b is made to carry out conduction of the cooling water through Piping 22b and 23b. This cooling water can use the about 29-degree C water supplied from a cooling tower.

[0023] If it does so, the interior of an evaporator 32 and housing 21b will be open for free passage, the adsorption material by which the refrigerant steam which evaporated with the evaporator 32 was formed in the outside surface of heat exchange member 20b will be contacted, and adsorption material will be adsorbed in a refrigerant steam. As a result of moisture's adsorbing in the adsorption material of this heat exchanger 20b, in an evaporator 32, evaporation advances further. In this case, since cooling water is carrying out conduction of the interior of heat exchanger 20b and heat exchanger 20b is cooled, even if generation of heat arises by the adsorption reaction of adsorption material, since adsorption material is cooled, adsorption effectiveness does not fall.

[0024] Thus, as a result of evaporation advancing with an evaporator 32, water is cooled by the latent heat of vaporization and cold water is manufactured.

[0025] On the other hand, since thermal wastewater is carrying out conduction of the interior in heat exchange member 20a, the adsorption material is heated and adsorption material carries out desorption of the moisture to which it was sticking at low temperature comparatively to the bottom of a vacuum. Since housing 21a is open for free passage with the condenser 33, it is cooled with a condenser 33 and moisture condenses the refrigerant steam which carried out desorption from adsorption material. In heat exchanger 20a, the desorption of moisture advances further by condensation of this moisture, and adsorption material is reproduced.

[0026] Thus, after playback of adsorption material is completed in heat exchange member 20a and water adsorption is completed in heat exchange member 20b, the closing motion valves 26a and 27b are made open, and the closing motion valves 26b and 27a are made close. If it does so, an adsorption process will be carried out in heat exchange member 20a, and a playback process will be carried out in heat exchange member 20b. Thus, cold water is continuously manufactured from an evaporator 32 by carrying out a playback process and an adsorption process by turns by the heat exchange members 20a and 20b.

[0027] In this example, since the heat exchange member 20 (20a, 20b) has a fin 12 like drawing 1 and the adsorption material 13 is formed also in this fin 12, an adsorption area is large, it is efficient, and moisture adsorbs. Moreover, in an adsorption process, since cooling water carried out conduction of the interior of the heat exchange member 20 and

adsorption material is cooled, even if generation of heat by the adsorption reaction arises, adsorption effectiveness does not fall and high adsorption effectiveness is maintained. Consequently, according to the adsorption equation refrigerator of this example, it is very efficient and cold water can be obtained. For this reason, a coefficient of performance is high.

[0028] Next, drawing 1 and the adsorption equation refrigerator shown in 2 are actually manufactured, and the result of having asked for the coefficient of performance is explained. The fin pitch of this heat exchange member is 3.5mm. The heating area of each heat exchange member is 2 29m, and the change of a closing motion valve, i.e., the change to a playback process and an adsorption process, is for 5 minutes. The acrylic adhesiveness binder was applied all over the plate fin made from aluminum, and 680g /of silica gels whose grain size is 20 thru/or 35 meshes was pasted up on the front face two times m. A heat carrier is 75-degree C thermal wastewater, and the cooling water of the medium inside the heat exchange tubing 1 is cooling tower water.

[0029] Consequently, that that whose warm water was 75 degrees C at the entrance fell to 70 degrees C at the outlet, and cold water's was [that] 14 degrees C at the entrance fell to 12 degrees C at the outlet. The heating value by the side of warm water was 63kW, and the heating value by the side of cooling water was 82.5kW. Consequently, coefficients of performance were 82.5 / 63= 1.31.

[Translation done.]

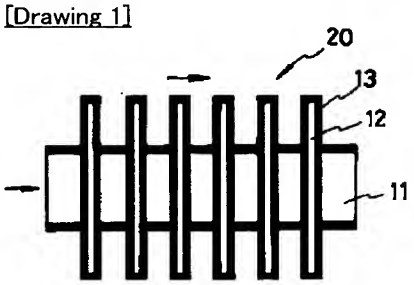
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the mimetic diagram showing the heat exchange member of the adsorption equation refrigerator concerning the example of this invention.
[Drawing 2] It is the block diagram showing the adsorption equation refrigerator of this example similarly.
[Drawing 3] It is the block diagram showing the conventional adsorption equation refrigerator.
[Drawing 4] It is drawing showing the ******** diagram similarly.
[Description of Notations]
1; evaporator
2; condenser
3 4; heat exchanger
7; adsorption material
8; refrigerant
11; heat exchange tubing
12; fin
13; adsorption material
20, 20a, 20b; heat exchange member
21a, 21b; housing
32; evaporator
33; condenser

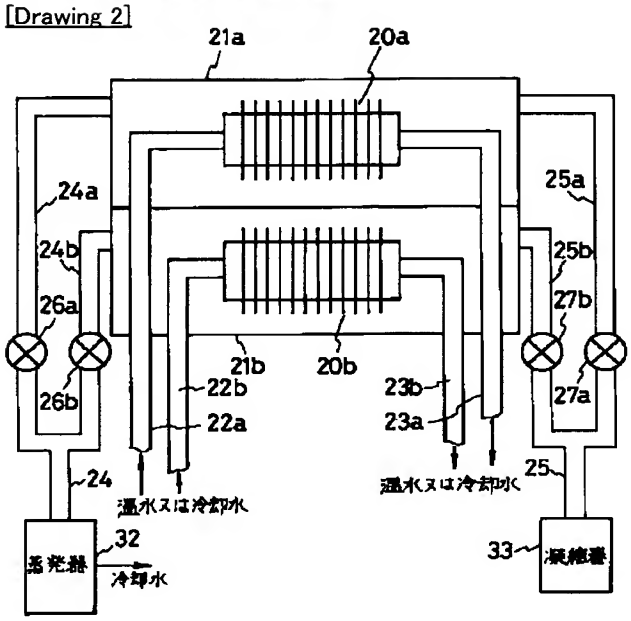
[Translation done.]

DRAWINGS

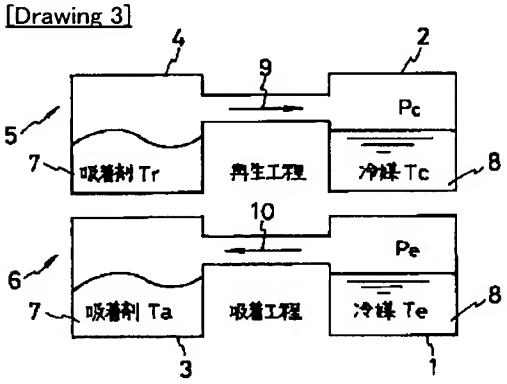
[Drawing 1]



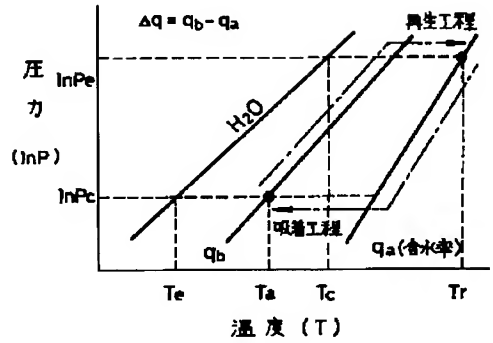
[Drawing 2]



[Drawing 3]



[Drawing 4]



[Translation done.]

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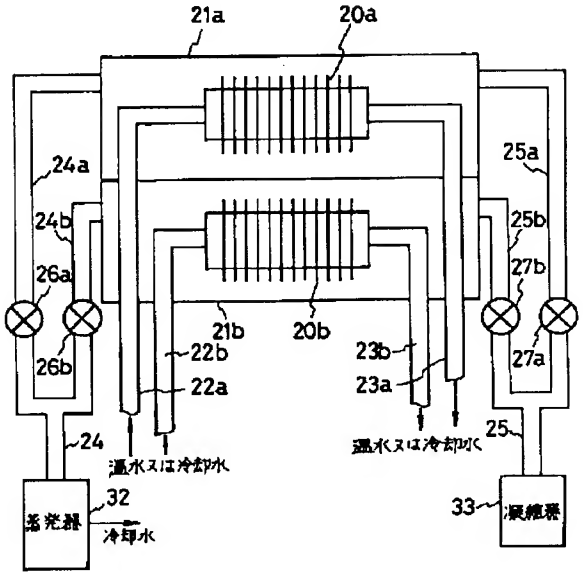
(54)【発明の名称】　吸着式冷凍機

(57)【要約】

【目的】　ランニングコストが低いという吸着式冷凍機の利点を生かしつつ、成績係数を向上させて効率を向上させることができる吸着式冷凍機を提供する。

【構成】　熱交換部材２０のフィンを含む外表面部分に水分吸着材が配置されており、一方の熱交換部材２０ｂの外表面部分に蒸発器３２から蒸発した空気を接触させて水分を吸着する。このとき発生する吸着熱は熱交換部材内を通流する冷却水により除去する。一方、他の熱交換部材２０ａの内部には温排水を通流させて加熱し、吸着材を脱着する。脱着した水分を含む空気は凝縮器３３にて凝縮する。この熱交換部材２０ａ、２０ｂにおける再生工程と吸着工程とを交互に実施することにより、蒸発器３２にて連続的に冷水を製造することができる。



【特許請求の範囲】

【請求項１】　外表面部分に水分吸着材が配置された筒状の熱交換部材と、蒸発器と、この蒸発器からの蒸気を前記熱交換部材の外側に通流させて水分を前記吸着材に吸着させる吸着手段と、この吸着時に前記熱交換部材の内側に冷却流体を通流させる冷却手段と、前記熱交換部材の内側に熱媒流体を通流させて前記吸着材を再生する再生手段と、この再生時に再生により前記吸着材から脱着した蒸気を凝縮する凝縮器と、を有することを特徴とする吸着式冷凍機。

【請求項２】　外表面部分に水分吸着材が配置された少なくとも２基の筒状の熱交換部材と、蒸発器と、この蒸発器からの蒸気を前記熱交換部材の外側に通流させて水分を前記吸着材に吸着させる吸着手段と、この吸着時に前記熱交換部材の内側に冷却流体を通流させる冷却手段と、前記熱交換部材の内側に熱媒流体を通流させて前記吸着材を再生する再生手段と、この再生時に再生により前記吸着材から脱着した蒸気含有再生ガスを凝縮する凝縮器と、前記熱交換部材を２群に分け前記熱交換部材に対する外側蒸気及び内側冷却流体の供給と前記熱交換部材に対する内側熱媒流体の供給及び外側再生ガスの抽出とを交互に実施する制御手段と、を有することを特徴とする吸着式冷凍機。

【請求項３】　前記熱交換部材はその外表面に複数個のフィンが設けられており、このフィンの表面も前記熱交換部材の前記外表面を構成していることを特徴とする請求項１又は２に記載の吸着式冷凍機。

【請求項４】　前記吸着材は、シリカゲル、ゼオライト、活性アルミナ及び活性炭からなる群から選択した少なくとも１種であることを特徴とする請求項１又は２に記載の吸着式冷凍機。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は低圧の密閉容器内での冷媒の蒸発潜熱を利用し、発生した冷媒蒸気を吸着材に吸着させ、連続して冷媒を蒸発させて冷熱を得る吸着式冷凍機に関し、特にプレートフィン型熱交換素子、シェルアンドチューブ型熱交換素子及びエロフィン型熱交換素子等の熱交換部材を使用して約５℃以上の冷水を製造するのに有効な吸着式冷凍機に関する。

【０００２】

【従来の技術】冷水を製造する手段として、蒸気圧縮式冷凍機を使用して冷媒が蒸発するときの蒸発潜熱により冷水を製造する技術と、吸収式冷凍機を使用して低温で水が蒸発するように減圧した容器内で水を蒸発させてその蒸発潜熱により冷水を製造する技術と、シリカゲルのペレットを吸着材として吸着式冷凍機により冷水を製造する技術とがある。

【０００３】従来、冷水の製造には、蒸気圧縮式冷凍機が一般的に使用されているが、この蒸気圧縮式冷凍機はフロンを使用しているため、近時の脱フロンの要請に反するものであり、また、凝縮熱が大きい水分を凝縮除去しようとするため、消費エネルギが高いという問題点がある。

【０００４】一方、吸収式冷凍機はフロンの問題は生じないものの、蒸気圧縮式冷凍機に比して、効率が悪く、この冷凍効率を上げようとすると、約８ｋｇｆ／ｃｍ^{2}Ｇの高圧蒸気が必要になる。このような高圧蒸気の供給装置は設置場所が制約されてしまい、蒸気圧縮式冷凍機に比して装置が大型化し、メインテナンスが難しいという難点がある。

【０００５】吸着式冷凍機は吸着材にシリカゲルを使用しているため、吸収式冷凍機に比して効率が悪いものの、工場及びコ・ジェネレイションシステム等の温排水を使用することによりランニングコストが極めて低くなり、また脱着時の温水温度の変動による効率の変化が少ないという利点がある。

【０００６】この吸着式冷凍機は、図３に示すように、吸着工程を実施する蒸発器１と吸着材熱交換器３とが、また再生工程を実施する凝縮器２と吸着材熱交換器４とが気密的に連結され、高真空に保持されるようになっている（クリーンエネルギー１９９３年２月号第３５乃至４０頁）。熱交換器３、４が２基設けられているが、これらはいずれも再生工程と吸着工程とが交互に実施され、それにより蒸発器１又は凝縮器２に交互に連結されるようになっている。蒸発器１の内部には、温度がＴｅの冷媒８が存在し、凝縮器２には温度がＴｃの冷媒８が存在する。この冷媒は水である。また、吸着材熱交換器３、４内には吸着材７が貯留されているが、再生工程の吸着材熱交換器４内の吸着材７は温度がＴｒ、吸着工程の吸着材熱交換器３内の吸着材７の温度はＴａである。この吸着材はシリカ系固体吸着材である。

【０００７】再生工程では、吸着材熱交換器４の吸着材７は熱源から熱を受けてその温度がＴａからＴｒに上昇し、吸着していた冷媒が水蒸気となって脱着され、この水蒸気が凝縮器２にて凝縮温度Ｔｃ（圧力Ｐｃ）で水となる。この操作により、図４に示す等吸着量線図において、吸着材の含水率がｑｂからｑａに移行する。

【０００８】また、吸着工程においては、吸着材熱交換器３内の吸着材７は冷却水等により温度がＴｒからＴａになるまで冷却されることにより、吸着材の飽和含水率がｑａからｑｂに増加するため、冷媒は系外から熱を奪い、蒸発器１において、蒸発温度Ｔｅ（圧力Ｐｅ）で気化し、吸着材７に吸着される。また、吸着時に発生する吸着熱は冷却水に奪われるようになっているため、吸着材７は温度がＴａに保持され、連続的に冷媒が吸着材７に吸着される。このような工程を２基の熱交換器３、４が交互に繰り返すことにより、蒸発器１から連続的に冷水が得られる。

【０００９】

【発明が解決しようとする課題】しかしながら、この従来の吸着式冷凍機は、冷水製造効率が低いという難点がある。例えば、冷水条件を、冷水入口で１４℃、冷水出口で１２℃、冷凍能力を１０ＵＳＲＴ（30240ｋｃａｌ／Ｈ）、冷却水入口温度を２９℃、温水入口温度を７５℃、蒸気を８ｋｇｆ／ｃｍ^{2}Ｇとすると、蒸気圧縮式冷凍機の場合には、圧縮機容量が７．５ｋＷ、最大流量を１２ｍ^3／時として、成績係数ＣＯＰが３．４と優れている。なお、この成績係数は、冷凍機において、熱量Ｑをくみ上げるのに、どれだけの仕事Ｗを消費するかという指標であり、冷凍機の効率を表すものである。但し、この蒸気圧縮冷凍機においては、圧縮機を駆動するのに電力が必要であり、このための発電効率を考慮すると、成績係数ＣＯＰは１程度となると考えられる。一方、吸収式冷凍機は蒸気消費量が４５ｋｇ／時であり、成績係数は１．２である。

【００１０】これに対し、吸着式冷凍機は成績係数が０．５６と、蒸気圧縮式冷凍機及び吸収式冷凍機に比して極めて低い。

【００１１】本発明はかかる問題点に鑑みてなされたものであって、ランニングコストが低いという吸着式冷凍機の利点を生かしつつ、成績係数を向上させて効率を向上させることができる吸着式冷凍機を提供することを目的とする。

【００１２】

【課題を解決するための手段】本発明に係る第１の吸着式冷凍機は、外表面部分に水分吸着材が配置された筒状の熱交換部材と、蒸発器と、この蒸発器からの蒸気を前記熱交換部材の外側に通流させて水分を前記吸着材に吸着させる吸着手段と、この吸着時に前記熱交換部材の内側に冷却流体を通流させる冷却手段と、前記熱交換部材の内側に熱媒流体を通流させて前記吸着材を再生する再生手段と、この再生時に再生により前記吸着材から脱着した蒸気を凝縮する凝縮器と、を有することを特徴とする。

【００１３】本発明に係る第２の吸着式冷凍機は、外表面部分に水分吸着材が配置された少なくとも２基の筒状の熱交換部材と、蒸発器と、この蒸発器からの蒸気を前記熱交換部材の外側に通流させて水分を前記吸着材に吸着させる吸着手段と、この吸着時に前記熱交換部材の内側に冷却流体を通流させる冷却手段と、前記熱交換部材の内側に熱媒流体を通流させて前記吸着材を再生する再生手段と、この再生時に再生により前記吸着材から脱着した蒸気含有再生ガスを凝縮する凝縮器と、前記熱交換部材を２群に分け前記熱交換部材に対する外側蒸気及び内側冷却流体の供給と前記熱交換部材に対する内側熱媒流体の供給及び外側再生ガスの抽出とを交互に実施する制御手段と、を有することを特徴とする。

【００１４】この場合に、前記熱交換部材には、その外表面に複数個のフィンが設けられており、このフィンの表面も前記熱交換部材の前記外表面を構成しているものであることが好ましい。

【００１５】また、前記吸着材としては、シリカゲル、ゼオライト、活性アルミナ又は活性炭がある。

【００１６】

【作用】本発明においては、筒状の熱交換部材の外表面に吸着材を設け、熱交換部材の内部に熱媒流体又は冷却流体を通流させて、熱交換部材の外表面の吸着材を加熱し、又は冷却する。これにより、例えば７５℃の温排水等の熱媒流体が通流している熱交換部材においては、吸着材が加熱されて再生工程が実施され、水分が脱着される。この脱着水分は蒸気となって凝縮器に入り、凝縮器で冷却されて凝縮される。一方、蒸発器において発生した蒸気は、熱交換部材の吸着材に接触して通流し、その水分が吸着材に吸着される。蒸発器においては、蒸発潜熱を奪われて冷却された冷水が得られる。この吸着工程においては、熱交換部材の内部に冷却流体を通流させるので、吸着熱により吸着材が昇温して吸着効率が低下するということもなく、常時高効率で吸着工程が実施される。このように、本発明においては、筒状の熱交換部材の外表面側と内側とで熱交換が実施されて吸着工程と再生工程とが交互に実施されると共に、この吸着工程においては、吸着材が冷却流体により冷却されているので、吸着効率が高い。従って、極めて優れた冷凍効率を得ることができ、成績係数を向上させることができる。

【００１７】

【実施例】以下、本発明の実施例について添付の図面を参照して具体的に説明する。図１は本発明の実施例に係る吸着冷凍機の熱交換部材２０を示す正面図である。熱交換管（銅管）１１には、複数のアルミニウムプレートフィン１２が嵌合されている。そして、これらの銅管１１の外周面及びフィン１２の表面の全面に、水分吸着材１３が配置されている。この吸着材１３は、例えば銅管１１の外周面及びフィン１２の表面の全面にアクリル粘着性バインダを塗布し、このアクリル粘着材バインダ膜にシリカゲル粒子を埋め込むようにして、添着することにより形成することができる。また、シリカゲルの粉末を水ガラスと共に混練し、これを銅管１１の外周面及びフィン１２の表面に押出して塗布した後、水ガラス分を乾燥焼成し、シリカゲル粉末と水ガラスをフィン表面等に固着することにより吸着材を設けることができる。いずれにしても、吸着材の粉末又は粒子を熱交換部材の表面に塗布し、又は接着することにより、固着すればよい。吸着材としては、シリカゲルの外に、ゼオライト、活性炭及び活性アルミナ等がある。

【００１８】また、図１に示す熱交換部材はプレートフィン型の熱交換素子であるが、このようなタイプのものに限らず、シェルアンドチューブ型又はエロフィン型の熱交換素子等を使用することもでき、更にフィンを有しない単管状の熱交換素子を使用してもよい。

【００１９】本実施例の吸着式冷凍機はこの熱交換部材２０（２０ａ、２０ｂ）を使用して図２に示すように構成されている。各熱交換部材２０ａ，２０ｂは夫々ハウジング２１ａ，２１ｂ内に気密的に収納されており、これらの熱交換部材２０ａ，２０ｂの内側には配管２２ａ、２２ｂを介して温水又は冷却水が供給されるようになっている。この温水又は冷却水は熱交換部材２０ａ，２０ｂの内部を通流して熱交換部材２０ａ，２０ｂを加熱し又は冷却した後、配管２３ａ、２３ｂを介して排出される。これらの配管２２ａ、２２ｂ，２３ａ，２３ｂはハウジング２１ａ，２１ｂの外部に導出されている。

【００２０】ハウジング２１ａ，２１ｂ内に連通する配管２４ａ，２４ｂがハウジング２１ａ，２１ｂの一方の端部に連結されており、また、ハウジング２１ａ，２１ｂの他方の端部には配管２５ａ，２５ｂが連結されている。配管２４ａ，２４ｂはいずれも配管２４に連結されており、ハウジング２１ａ，２１ｂはこれらの配管２４，２４ａ，２４ｂを介して蒸発器３２に連結されている。一方、配管２５ａ，２５ｂはいずれも配管２５に連結されており、これらの配管２５、２５ａ，２５ｂを介してハウジング２１ａ，２１ｂは凝縮器３３に連結されている。

【００２１】配管２４ａ，２４ｂには開閉弁２６ａ、２６ｂが設けられており、配管２５ａ、２５ｂには開閉弁２７ａ，２７ｂが設けられている。これらのハウジング及び配管はいずれも気密に保持されている。また、ハウジング２１ａ，２１ｂ内は真空状態に保持されている。

【００２２】次に、このように構成された吸着式冷凍機の動作について説明する。先ず、熱交換部材２０ａが再生工程、熱交換部材２０ｂが吸着工程を実施しているとする。開閉弁２６ａ、２７ｂを閉、開閉弁２６ｂ、２７ａを開にする。また、配管２２ａ、２３ａを介して熱交換部材２０ａの内部に温水を通流させる。この温水は工場において温排水として排出されているものを使用することができる。また、配管２２ｂ，２３ｂを介して熱交換部材２０ｂの内部に冷却水を通流させる。この冷却水はクーリングタワーから供給される２９℃程度の水を使用することができる。

【００２３】そうすると、蒸発器３２の内部とハウジング２１ｂ内部とが連通し、蒸発器３２にて蒸発した冷媒蒸気が熱交換部材２０ｂの外表面に設けられた吸着材と接触し、冷媒蒸気が吸着材に吸着される。この熱交換器２０ｂの吸着材にて水分が吸着される結果、蒸発器３２においては更に蒸発が進行する。この場合に、熱交換器２０ｂの内部は冷却水が通流していて熱交換器２０ｂが冷却されているので、吸着材の吸着反応により発熱が生じても、吸着材は冷却されているため、吸着効率が低下することはない。

【００２４】このようにして、蒸発器３２にて蒸発が進行する結果、蒸発潜熱により水が冷却されて冷水が製造される。

【００２５】一方、熱交換部材２０ａにおいては、その内部を温排水が通流しているので、その吸着材が加熱され、吸着材は吸着していた水分を真空下において比較的低温で脱着する。ハウジング２１ａは凝縮器３３と連通しているので、吸着材から脱着した冷媒蒸気は凝縮器３３にて冷却されて水分が凝縮する。この水分の凝縮により熱交換器２０ａにおいては、更に水分の脱着が進行し、吸着材が再生される。

【００２６】このようにして、熱交換部材２０ａにて吸着材の再生が終了し、熱交換部材２０ｂにて水分吸着が終了した後、開閉弁２６ａ、２７ｂを開、開閉弁２６ｂ，２７ａを閉にする。そうすると、熱交換部材２０ａにて吸着工程が実施され、熱交換部材２０ｂにて再生工程が実施される。このようにして、熱交換部材２０ａ、２０ｂにて再生工程と吸着工程とを交互に実施することにより、蒸発器３２から冷水が連続的に製造される。

【００２７】本実施例においては、図１のように熱交換部材２０（２０ａ、２０ｂ）がフィン１２を有し、このフィン１２にも吸着材１３が設けられているので、吸着面積が広く、高効率で水分が吸着される。また、吸着工程においては、熱交換部材２０の内部を冷却水が通流して吸着材を冷却しているので、吸着反応による発熱が生じても吸着効率が低下することはなく、高吸着効率が維持される。その結果、本実施例の吸着式冷凍機によれば、極めて高効率で冷水を得ることができる。このため、成績係数が高い。

【００２８】次に、実際に図１、２に示す吸着式冷凍機を製造し、成績係数を求めた結果について説明する。この熱交換部材のフィンピッチは３．５ｍｍである。各熱交換部材の伝熱面積は２９m^2であり、開閉弁の切替、即ち再生工程と吸着工程との切替は５分間である。アルミニウム製プレートフィンの全面にアクリル粘着性バインダーを塗布し、その表面に粒度が２０乃至３５メッシュのシリカゲルを６８０ｇ／m^2接着した。熱交換管１の内部の媒体は熱媒体が７５℃の温排水であり、冷却水がクーリングタワー水である。

【００２９】その結果、温水は入口で７５℃であったものが出口で７０℃に低下し、冷水は入口で１４℃であったものが出口で１２℃に低下した。温水側の熱量は６３ｋＷであり、冷却水側の熱量は８２．５ｋＷであった。その結果、成績係数は、８２．５／６３＝１．３１であった。

【００３０】

【発明の効果】以上説明したように、本発明によれば、吸着式冷凍機のランニングコストが低いという利点を生かしつつ、その成績係数を他の蒸気圧縮式冷凍機及び吸収式冷凍機の成績係数以上に高めることができる。このため、本発明は冷水を極めて高効率で製造することができるという優れた効果を奏する。

【図面の簡単な説明】

【図１】本発明の実施例に係る吸着式冷凍機の熱交換部材を示す模式図である。

【図２】同じく本実施例の吸着式冷凍機を示すブロック図である。

【図３】従来の吸着式冷凍機を示すブロック図である。

【図４】同じくその等吸着量線図を示す図である。

【符号の説明】

１；蒸発器

２；凝縮器

３、４；熱交換器

７；吸着材

８；冷媒

１１；熱交換管

１２；フィン

１３；吸着材

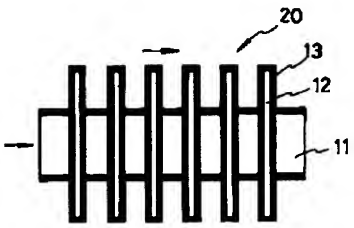
２０、２０ａ、２０ｂ；熱交換部材

２１ａ、２１ｂ；ハウジング

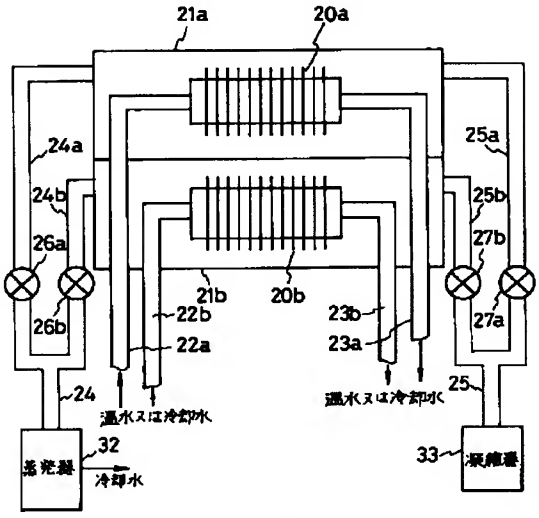
３２；蒸発器

３３；凝縮器

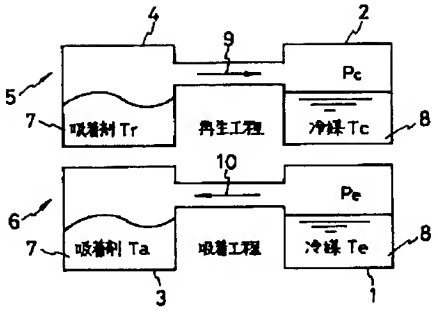
【図１】



【図２】



【図３】



【図４】